Layer Transfer Using Implant and Exfoliation Techniques

K.D. Hobart and F.J. Kub

Naval Research Laboratory
Electronics Science and Technology Division
Washington, D.C. 20375

Since the realization of silicon thin film transfer by wafer bonding and hydrogen ion implantation and exfoliation (Smart Cut®) by Bruel in 1995[1], several teams have succeeded in transferring a variety of semiconductor films including GaAs[2], InP[3,4], SiC[5,6,7], Ge[8], GaSb[9,10], $SrTiO_3$[11], $LaAlO_3$ and sapphire[12]. In addition to using hydrogen ion implantation, He[13], He and H[13,14], H and B[15,16] and Si and H[17] co-implantations have been successfully used to realize either reduced total dose and/or temperature required for exfoliation of Si. To transfer useful films, a stiffener substrate must be bonded to the implanted substrate as in, for example, the UNIBOND SOI fabrication process[18]. Suitable wafer bonding techniques must provide the required bond strength in order to direct the internal forces of exfoliation parallel to the bond interface allowing the transfer of a continuous semiconductor film. The exfoliation temperature maybe relatively low, and accordingly, low-temperature wafer bonding techniques are required. For example, exfoliation and layer transfer have been performed at temperatures as low as 300°C in Si co-implanted with H and B[15]. More recently, room temperature cleaving has been achieved by mechanical separation of the film and substrate[19,20]. These processes require very high bond strength at room temperature which have been achieved thus far by plasma preparation of the bonding surfaces.

This paper will review recent progress in thin film transfer using implantation and exfoliation. Key applications will be reviewed and progress cited.

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